Process for continuously coating the inside of an extruded thermoplastic polymer tube.

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Abstract of **EP 0530617 (A1)**

For continuously coating the inside of an extruded thermoplastic polymer tube, a rigid thermoplastic having a glass transition temperature above 50 DEG C is continuously extruded to form a polymer tube extrudate and after cooling below the glass transition temperature, led with elastic curvature along a downwardly curved arcuate path, where the inner wall of the hollow extrudate comes into contact with a reserve of a low viscosity coating agent which can wet the thermoplastic, the reserve remaining stationary there. After it has passed through this path section, the hollow chamber extrudate is guided upwards until the entrained excess of liquid coating agent has run back into the reserve. Subsequently the film of coating agent remaining on the polymer surface is cured to form a hard coating.

Result Page

The invention relates to a continuous process to the interior coating of an extruded hollow section, guided with which a thermoplastic resin continuous becomes a hollow section strand extruded and this by a downward curved, arcuate passageway, whereby the inner wall of the hollow strand with there stationary remaining supply of a liquid coating agent into contact steps.

State of the art

Methods of the upper described type are known to the interior coating of soft reading tables hoses. In accordance with JP-A 86/193 827 extruded PE hollow section strand becomes an inflated by means of compressed air a tubular sheeting, this between a pair of rolls flat-placed and by a downward curved, arcuate passageway guided. At the lower apex of this arcuate path a supply of a coating agent is stationary disposed before a pair of rolls. After the passage by the nip only a thin film remains on the inner walls of the tubular sheeting. After renewed inflation of the hose the film becomes cured on suitable manner.

Much a similar process is in the DE-B 28 01 038 described, even if the production of the hose is procedure-moderate separate of the interior coating. With this method the hose periodic is punctured for the refill of the coating agent.

In principle similar procedures are from DEK 25 57 994, DEK 31 13 959 and EP-B 62,812 known. All methods is common that the hose is soft-elastic during the coating method, so that the supply of the liquid coating agent can be manipulated by squeegee rollers, which squeeze the hose together flat, in various manner. In particular an excess of the coating agent from the film light can be led back, if the inside coated hose in the nip of a pair of squeezing rollings becomes flat-pressed and the film on a low thickness limited.

The interior coating of hollow section watering gene from rigid materials different methods applied became so far fundamental. In accordance with DE-A 22 05 739 a metal pipe on a sheath press continuous manufactured and simultaneous becomes by means of a coaxial spray device a thermoplastic resin introduced and up-sintered passed by the press tool. For the interior coating of extruded plastic hollow sections will in DE-A 24 04 236 proposed to lead a liquid coating agent with the help of a pipe across the extrusion head into the interior of the extruded hollow section to spray and equalize there. From evaporation of water or solvent a solid coat results from the liquid coating agent. These procedures set a very expensive construction of the pressing and/or. Extruding tool ahead, which must contain a thermal isolated channel for the feed line of the coating agent. The construction of an extrusion die for hollow chamber plates with a variety separate hollow chambers would be corresponding more complicated.

Object and solution

The invention is the basis the object to attach with the continuous extrusion of a thermoplastic resin rigid with room temperature to a hollow section strand a simultaneous interior coating without leading the coating agent by the extrusion die.

The object becomes dissolved by the method in accordance with the claims. The invention takes advantage of the limited pliancy, which also a hollow section strand from rigid plastic is to own. The hollow section strand becomes guided by a downward curved, arcuate passageway, where the inner wall of the hollow strand with there stationary remaining supply of a liquid coating agent into contact steps. Since the plastic is rigid, all manipulations of the enclosed supply of the coating agent forbid themselves. In order to reach an uniform coating of the inner wall of the hollow section strand nevertheless, a highly liquid coating agent used wettingable opposite the thermoplastic resin becomes according to invention. After that passes of the run way section, where the supply of the coating agent is, the hollow section strand becomes upward guided until the carried along excess of the liquid coating agent ran back into the supply. The film of the coating agent stayed on the plastic surface becomes a solid coat cured.

An apparatus to the carrying out the method is in fig 1 schematic shown in a vertical sectional view.

Preferable embodiment

From an extrusion equipment, a contained extruder, an extruding slot nozzle and a cooled vacuum-form channel, not represented in fig 1, a continuous rigid hollow chamber course becomes 1, existing from two parallel outer walls 1 ' and 1 '' and a variety of rectangular bars, after cooling the bottom glass transition temperature by means of a propelled pair of rollers 2, disposed in addition, 3 with uniform rate in arrow direction peeled. By means of the rollers 3, 4, 5 the web bottom elastic bend becomes by a downward curved arcuate passageway 6 guided and promoted at its end a not represented separator. In the lower apex the roller 4 current works against the curved path 6 the elastic restoring force of the curved path.

In the range of the lower apex of the web a supply 7 of the liquid coating agent is in the hollow chambers. Its amount becomes always so large held that the liquid level the inside of the upper outer wall 1 ' touched. In the ascending range of the web warm emitters are 8 disposed, whose radiation is on the outside of the web directed and warms up in such a way it that a part of the volatile liquid from the film of the coating agent evaporated carried along at the inner walls of the web.

The thickness of the film depends on several factors, i.e.

a) of the viscosity and the surface tension of the coating agent,
b) of the slope of the ascending way section above the liquid level,
c) of the length of this way section,
d) of the roughness of the inner wall of the web,
e) of the completeness of the wetting,
f) of the wall temperature.
Usually the film up to a thickness to a large extent same at all wall sections runs off. It usually is about 1 to 100 micrometers.

If one would not like itself to let the film thickness adjust due to the mentioned factors, the coating agent in a predetermined thickness can become on the inner walls of the hollow chamber distributed also by means of in the hollow chamber stationary staying dragging plug.

The coating agent becomes only filled into the hollow chamber, after a sufficient prolonged piece of the hollow section course extruded and by the passageway 6 guided is. The filling a convenient apparatus becomes 10 used, which is lifted for the durations of the filling by means of hydraulics 11 into the position located over the passageway 6 in accordance with Fig.1. The filling device 10 is 12 parallel at rails to the passageway of the web more mobile and can by means of an hydraulic brake 13 at the continuous moved web clamp itself. The apparatus 10 contains a tool 14, with which in the upper outer wall 1 ' of the web an hole generated can become. The tool 14 becomes for this purpose pressed by means of hydraulics 15 against the outer wall 1 '. In order not to contaminate the coating by drilling splinters, it is favourable to produce the hole by a non-cutting working method; e.g. by one over the melting temperature of the thermoplastic resin heated mandrel, which is pushed hydraulic by the wall 1 '. Into the hole a filling tube becomes 17 introduced by means of hydraulics 16, by which over a valve 18 from a reservoir 19 a suitable amount liquid coating agent of the filled becomes. It is convenient to preheat the coating agent on the temperature which also the supply 7 in the operating condition has. Afterwards the filling tube becomes 17 from the hole withdrawn, the filling device 10 after release of the brake 13 and into the passageway 6 lowered returned at the rails 12 into the starting position. The punched web section becomes, as soon as it arrives at the separator, separated and discarded. It understands itself that the described elements 14 to 18 of the apparatus must be 10 multiple present, if the extruded web contains several separate hollow chambers next to each other and these simultaneous filled to become to be supposed. If necessary a single set of these elements, if a complementary apparatus is present is sufficient, in order to move the filling device on 10 transverse to the extrusion direction from an hollow chamber to the other one.

For a rational manufacturing way it is convenient to let the operations of the filling device 10 by means of a suitable programme control automatic run off. The programme can become automatic in each case triggered, if the supply of the coating agent up to a certain minimum amount is consumed. If one becomes much thin coating applied, a filling for a service life of several hours is enough.

The coated web becomes after leaving the curved passageway 6 of a separator supplied, where it becomes divided into sections of desired length. Conventional separators, which are more mobile parallel just like the filling device 10 at rails to the passageway of the web and clamp themselves during the separation process at the moved web, contain crosswise over the web width continuous circular saws with splinter exhaust. If the coating is to the time of the separation of a web section not yet drying, unavoidably sawdust come on the coating and remain with drying clinging there. This can be avoided, if one only cuts the outer walls or notches and breaks the web section off in this place. The bars break simultaneous also. Instead also the outer walls with an hot knife can be non-cutting melted through. The coating can become in the separated web sections by warm air, which becomes blown by the hollow chamber, dried.

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The thermoplastic resin

For the method of the invention rigid, thermoplastic extrudable plastics with a modulus of elasticity of at least 1000 MPa, measured with 20 o< C> according to DIN 53457 are preferably suitable, 1500 to 4000 MPa. Its glass transition temperature (DIN 7724) amounts to at least 50< o> C, preferably 70 to 200< o> C. Prefered ones are typical construction plastics for the building industry, which are characterised by hardness and rigidity as well as by resistance against influences of the weather, in particular PMMA and PC. Suitable ones are also PVC, HP and EXP.

The hollow section

As hollow sections extruded strands with constant profile become regarded in the sense of the invention, which contain at least a continuous cavity. In addition belong pipes as well as frame profiles, rung profiles and other technical profiles with more or less complicated sectional shapes and if necessary several cavities. The wall thickness the cavity enclosing plastic layer amounts to usually 0.1 to 5 mm. Prerequisite for the processability after the method of the invention is an elastic pliancy of the extruded hollow section in extrusion direction, which permits at least with dense the bottom glass transition temperature located temperatures bending radiuses from approximately 1 to 100 m. Such a pliancy is usually given, if the hollow section is not thicker as 40 mm. Preferably according to invention hollow chamber plates become generated and coated.

The coating agent

The need of an interior coating results from the respective application of the hollow section. Thus e.g. became. in the EP-B 201,816 proposed, an hollow chamber plate from plastic on the outside and inside with a coat of lower optical refractive index than providing that of the plastic. Thus reflection losses of the falling through light become reduced and the entire light permeability increased.

A prefered application of the invention process insists in jobs of a water-spreading coating on the interior surfaces of hollow chamber plates. The need of such a coating results in the case of glazings of greenhouses and other humid rooms. Coating agents for this purpose e.g. are. from the EP-B 149,182 known.

It is not to remain unmentioned however that if required by means of the invention also several layers successively applied to become to be able, by leading the hollow section course successively by several coating zones designed in the sense of the invention. Prerequisite is that the primary coating can become cured, before the web occurs the second coating zone. In this way for example a adhesion-promoting primer for the second coating can be produced.

For the method of the invention highly liquid coating agents with a viscosity become within the range of 1 to 4000 mPa s used.
Important one is a proper wetting of the plastic surface by the liquid coating agent, so that a closed film forms. If that is not the case, a wetting agent can become added.

A physical drying liquid coating agent in most cases becomes inserted, which consists of a solved, a dispersed or a suspended non or heavy-volatile coating agents and of a volatile liquid. As examples are mentioned:

1) For the formation of a water-spreading coating is suitable a colloidal suspension of silica in waters with a silicic acid content from 0,1 to 15 Gew. - %. It preferably contains 1 to 10 Gew. - %, related to the silica, a water-soluble, preferably non-ionic wetting agent, like e.g. oxethylierte their viscosity amounts to 2 to 25 mPa s with 25< o> C.
2) An optical effective coating from low optical refractive index to the improvement of the light transmission can from a solution fluorine containing polymers, e.g. a PVDF/PMMA mixture, in a volatile organic solvent, like methyl ethyl ketone, Cyclohexanon or dimethylformamide, formed become.

The liquid used as release or suspending agents should be with a temperature below the softening temperature of the coated plastic volatile. Except waters low alcohols, like methanol or isopropyl alcohol, come Ketone, like acetone or methyl ethyl ketone, chlorinated hydrocarbons or aromatics into considerations. Liquids, which solve the plastic of the hollow section strand or pour, can lead and become to cracking and corrosion as avoided ones as possible.

In particular cases reactive coating agents can become inserted, which are more curable by a chemical reaction. If the reactive components themselves are highly liquid, can be done without the addition of a volatile liquid as release or suspending agents.

EXAMPLE

Embodiment

A bar double disk course of 980 mm of width and 16 mm of thickness, which is divided by vertical bars standing to the surface in 32 same-wide chambers, is extruded continuous with a speed of 500 mm/min and in a vacuum-form channel the bottom softening temperature cooled. Those horizontal current web is passed on in 2500 a prolonged web section by a downward curved passageway guided and afterwards horizontal to a separator. The deepest point of the passageway lies 110 mm the bottom level of the horizontal course. In the ascending part of the passageway become with an angle of inclination of 10< o> to the horizontal one periodic with the mandrels equipped lowerable in fig of 1 illustrated apparatus, which with 32 over the melting temperature of the PMMA heat up, melted, simultaneous large into all chambers about filling holes 10 mm. By these holes becomes for each chamber 200 ml a netzmittelhaltigen, 5% aqueous flint oil filled. This filling amount is enough for a service life from 10 to 20 hours. The filling in the hollow chambers accepts a constant temperature of 55 o C by the heating by< the extruded> web. The separated web sections inertial at the inner walls of the hollow chamber a coating film of 2 - 6 micrometers thickness, which becomes dried by injecting warm air and leaves a water-spreading coating from 100 to 300 Nm thickness.

Result Page

1. Method to the continuous interior coating of an extruded hollow section from thermoplastic resin by continuous extrusion of the thermoplastic resin to an extruded hollow section strand, leading the hollow section strand by, an arcuate passageway gekümmten downward, where the inner wall of the hollow strand with there stationary remaining supply of a liquid coating agent into contact steps,

thus characterized,

that a rigid thermoplastic resin with a glass transition temperature over 50< o> C is extruded that the hollow section strand becomes guided after cooling the bottom glass transition temperature bottom elastic curvature by the arcuate passageway that a highly liquid coating agent wettingable opposite the thermoplastic resin becomes used that the hollow section strand after that passes of the run way section, where the supply of the coating agent is, as long as upward guided becomes, until the carried along excess of the liquid coating agent ran back into the supply, and that the film of the coating agent stayed on the plastic surface becomes a solid coat cured.

2. Process according to claim 1, characterised in that a liquid coating agent inserted becomes, from a solved, a dispersed or a suspended non or heavy-volatile coating agents and from a volatile liquid exists and a viscosity not over 4000 mPa s has.

3. Process according to claim 1 or 2, characterised in that a water-spreading coating applied becomes.

4. Methods after or the several claims a 1 to 3, characterised in that of the interiorcoated hollow section strand of sections of desired length by non-cutting separation separated become.

5. Method after or the several claims a 1 to 4, characterised in that the supply of the füssigen coating agent periodic supplemented becomes, as in the wall of the hollow section strand during the passage by the upward guiding part of the passageway an hole generated and the liquid coating agent becomes by the hole into the interior hollow section of the filled.

6. Process according to claim 5, characterised in that the hole by means of a tool generated heated over the melting temperature of the thermoplastic resin becomes non-cutting.

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